Total No. of Questions: 8]

SEAT No. :

P340

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[6003]-421

T.E. (Mechanical /Mechanical Sandwich Engg.)

HEAT AND MASS TRANSFER

(2019 Pattern) (Semester-I) (302042)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.***
2) ***Figures to the right indicate full marks.***

Q1) a) Explain briefly various regimes in pool boiling with sketch of typical pool boiling curve. **[6]**

b) Explain the following Non-dimensional numbers **[4]**

i) Reynold Number

ii) Grashoff Number

c) Water flows at a velocity of 12 m/s in a straight tube of 60 mm diameter. The tube surface temperature is maintained at 70 °C and the flowing water is heated from the inlet temperature of 15 °C to an outlet temperature of 45 °C. Taking the physical properties of water at the mean bulk temperature of 30°C as ρ = 995.7kg/m^3, Cp=4.174kJ/kgk, k= 61.718× 10^{-2} W/mK, ν = 0.805 x10^{-6} m^2/s and Pr = 5.42, Use correlation, $Nu_d = 0.023(Re_d)^{0.8}(Pr)^{0.4}$. Calculate (a) the heat transfer coefficient from the tube surface to the water, (b) the heat transfer and (c) the length of tube. **[8]**

OR

Q2) a) Distinguish between filmwise and dropwise condensation **[4]**

b) Explain the thermal boundary layer formation for flow over a flat plate with sketch. **[6]**

c) A 6 m long and 8 cm diameter horizontal hot water pipe passes through a large room whose temperature is 20 °C. If the outer surface temperature of the pipe is 70 °C, determine the rate of heat loss from the pipe by natural convection. The properties of air at 45 °C are, K = 0.02699 W/mK, Pr = 0.7221, ν = 1.749*10^{-5} m^2/sec, Use correlation $Nu = [0.6+(A/B)]^2$ Where, A = 0.387 $(Gr.\ Pr)^{(1/6)}$ and $B=[1+(0.559/Pr)^{(9/16)}]^{(8/27)}$ **[8]**

P.T.O.

Q3) a) Explain following Laws of Radiation **[8]**

i) Stefan - Boltzmann Law

ii) Plank's Law

iii) Kirchoff's Law

iv) Wein's Displacement Law

b) The radiation shape factor of the circular surface of a thin hollow cylinder of 10 cm diameter and 10 cm length is 0.1716. What is the shape factor of the curved surface of the cylinder with respect to ifself? **[4]**

c) Two parallel plates have emissivity of 0.8 and 0.5. A radiation shield having same emissivity on both sides is placed between them. Calculate the emissivity of the shield in order to reduce the radiation losses form system to one tenth of that of without shield. **[5]**

OR

Q4) a) Explain the following terms **[8]**

i) Gray Body

ii) Monochromatic emissivity

iii) Radiation Intensity

iv) Radiocity

b) A Furnace Cavity which is in the form of cylinder of 75mm diameter and 150 mm length is open at one end to large surrounding that is at 27 °C. The curved surface -3 and bottom surface-2 are aproximated as black surfaces and electrically heated The curved surface -3 and bottom surface -2 are maintained at 1350°C and 1650 °C respectively and outer surfaces are well insulated. Take view factor-F23 = 0.06. Estimate heat loss by radiation from opening-1 of the furnace **[4]**

c) A pipe carrying steam, having an outside diameter of 20cm runs in a large room and is exposed to air at a temperature of 30 °C. The pipe surface temperature is 200°C Find the total heat lost per meter length of the pipe taking the emissivity of the pipe surface as 0.8 and convective heat transfer coefficient as 7W/m^2°C. **[5]**

Q5) a) State and Explain Fick's Law of Diffusion **[6]**

b) A vessel contains a binary mixture of O_2 and N_2 with partial pressure in the ratio 0.21 and 0.79 at 15 °C. The total pressure oif the mixture is 1.1 bar. Calculate the following **[8]**

i) Molar concentrations

ii) Mass densities

iii) Mass fractions and

iv) Molar fraction of each species

c) Write applications of mass transfer **[4]**

OR

Q6) a) Derive the general mass transfer equation in cartesian coordinates. **[6]**

b) Hydrogen gas is maintained at pressures of 2.4 bar and 1 bar on opposite sides of a plastic membrane 0.3mm thick. The binary diffusion coefficient of hydrogen in the plastic is 8.6×10^{-8} m^2/s and solubility of hydrogen in the membrane is 0.00145 kg moles / m^3-bar. Calculate, under uniform temperature conditions of 24 °C, the following **[8]**

i) Molar Concentrations of hydrogen at the opposite faces of the membrane and

ii) Molar and mass diffusion flux of hydrogen through the membrane.

c) Explain modes of mass transfer **[4]**

Q7) a) Derive an expression for Logarithmic Mean Temperature Difference (LMTD) for parallel flow heat exchanger. **[6]**

b) Draw temperature profile diagrams for parallel flow heat exchanger and condenser. **[4]**

c) In a double pipe heat exchanger hot water flows at the rate of 5000kg/h and gets cooled from 95°C to 65°C. At the same time 50000kg/h of cooling water at 30°C enters heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 W/m^2K. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for both the streams C_p=4.2 KJ/kg K. **[7]**

OR

Q8) a) Derive an expression for effectiveness for parallel flow heat exchanger in terms of heat capacity ratio (C_{min}/C_{max}) and Number of Transfer Unit (NTU) **[6]**

b) What are the types of heat exchanger? **[4]**

c) A counter-flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500kg/h. The stem enters the heat exchanger at 180°C and leaves at 130°C. The inlet and exit temperatures of water are 30°C and 80°C respectively. If Overall Heat Transfer Coefficient from steam to water are 30°C and 80°C respectively. If overall heat transfer coefficient from steam to water is 814W/m^2°C, Calculate the heat transfer area. What would be the increase in area if the fluid flows were parallel? **[7]**